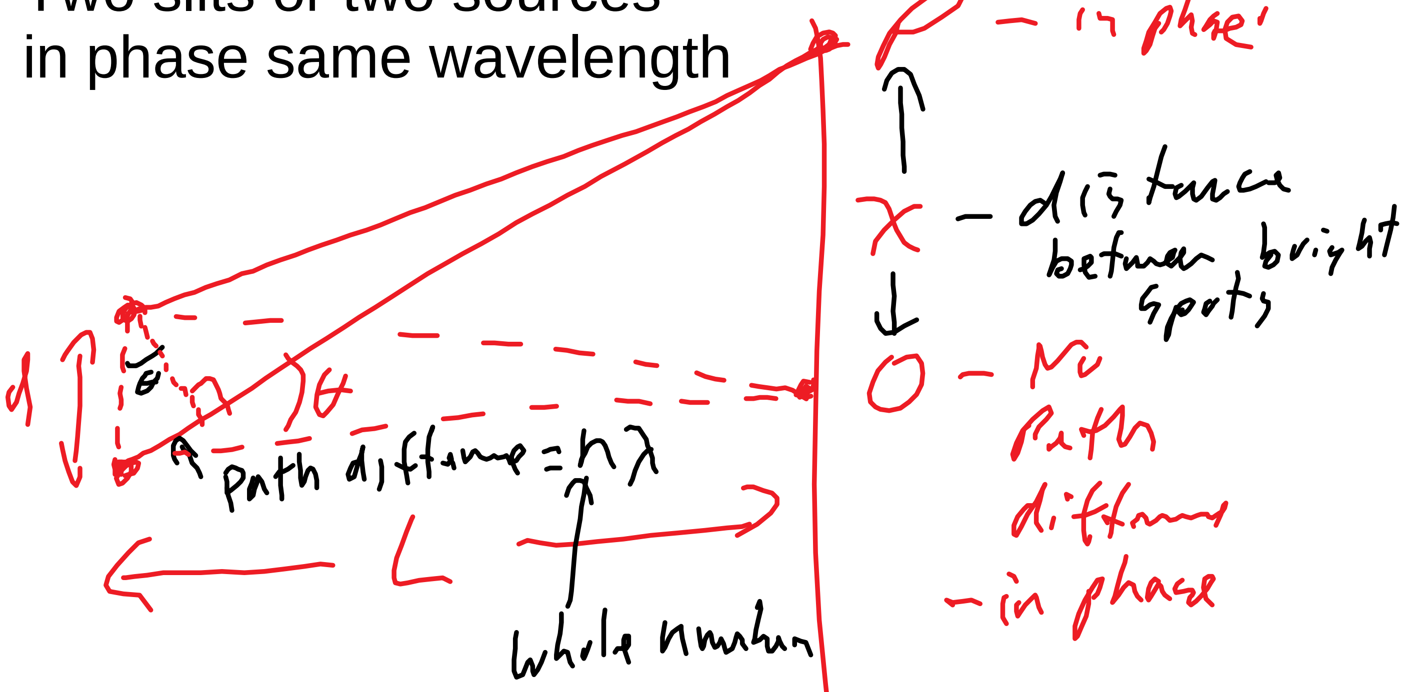
Two slits or two sources in phase same wavelength



$$\boxed{\sin\theta = \frac{n\lambda}{d}}$$ ⇐ double slit or double source

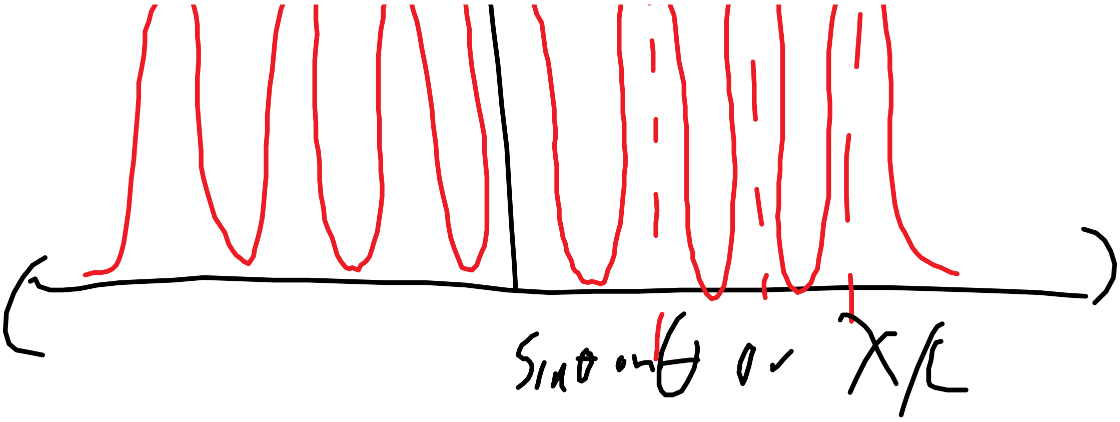
$$\frac{x}{L} = \tan\theta$$

for small θ

$$\tan\theta \sim \sin\theta \sim \theta$$ ← in radians

π radians = 180°

$$\frac{x}{L} \simeq \frac{n\lambda}{d}$$

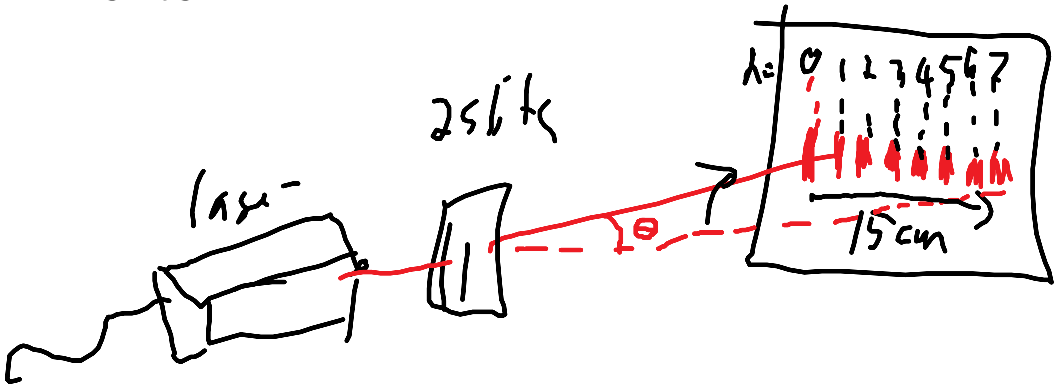


x is the distance between the centre of the bright bands, in m.
L is the distance from the slits/sources to the screen, in m.
λ is the wavelength, in m.
d is the distance between the slits/sources in m.
n is the number of bright bands (whole).
θ is the angle between bright bands seen from the slits/sources, in Radians.

This equation also works for multiple slits or a diffraction grating, with the more slits, the narrower the band.

eg. A helium-neon laser produces coherent(in phase) light of a wavelength of 632.8 nm. We shined the light through double slits and observed a set of bright bands on the screen at the back of the class. If there were 8 bands over 15.0 cm on a screen 3.20m away from the two slits, what is the distance between the

slits?



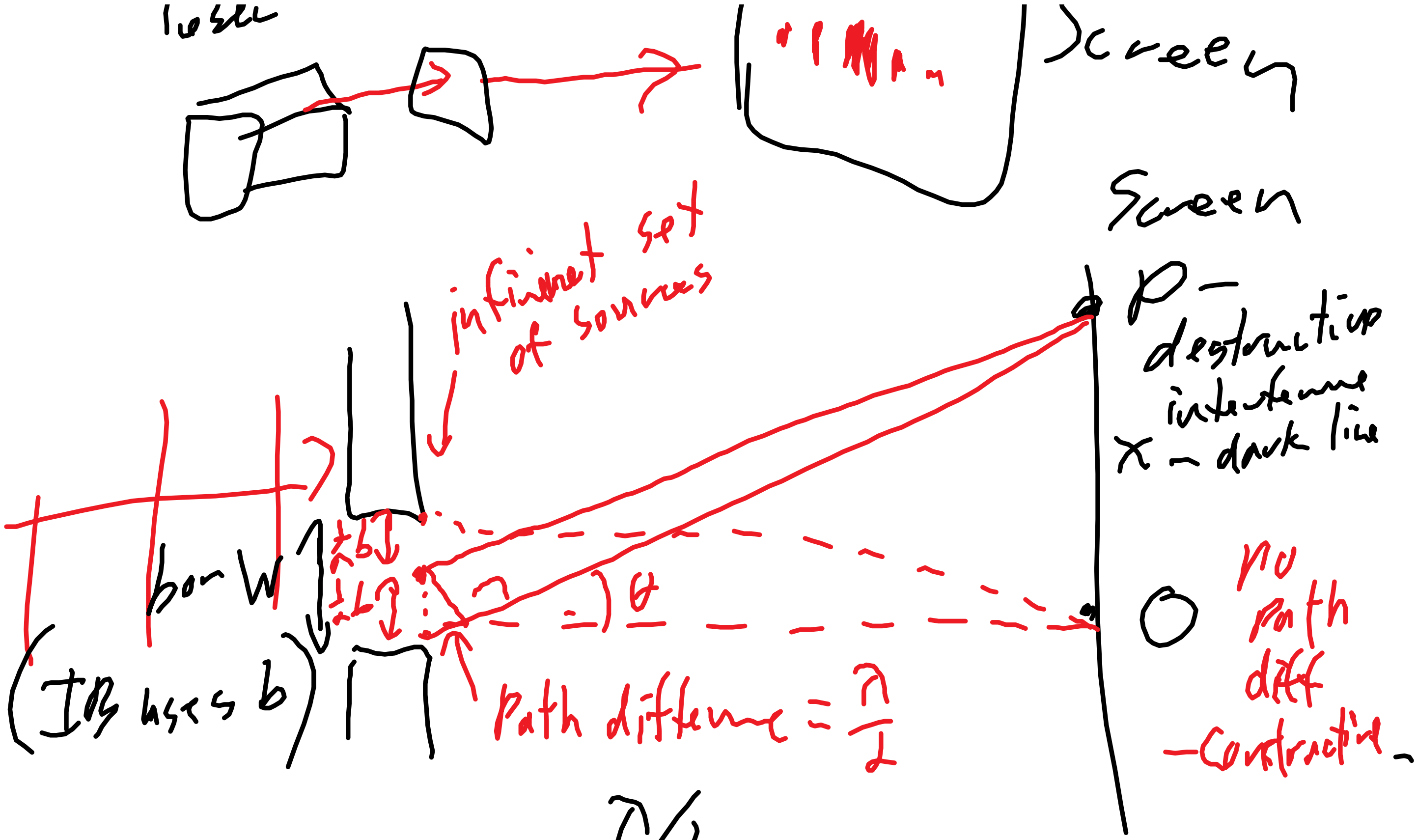
$$\frac{x}{L} = \frac{n\lambda}{d} \qquad d = \frac{n\lambda L}{x}$$

$$d = \frac{(7)(6.328 \times 10^{-7}\,m)(3.2\,m)}{0.150\,m}$$

start counting at 0

$$d = 9.5 \times 10^{-5}\,m$$

Single Slit
We found the light made a central bright band with smaller bands to the side when we shone the light through a single slit.



$$\sin\theta = \frac{\lambda/2}{b/2}$$

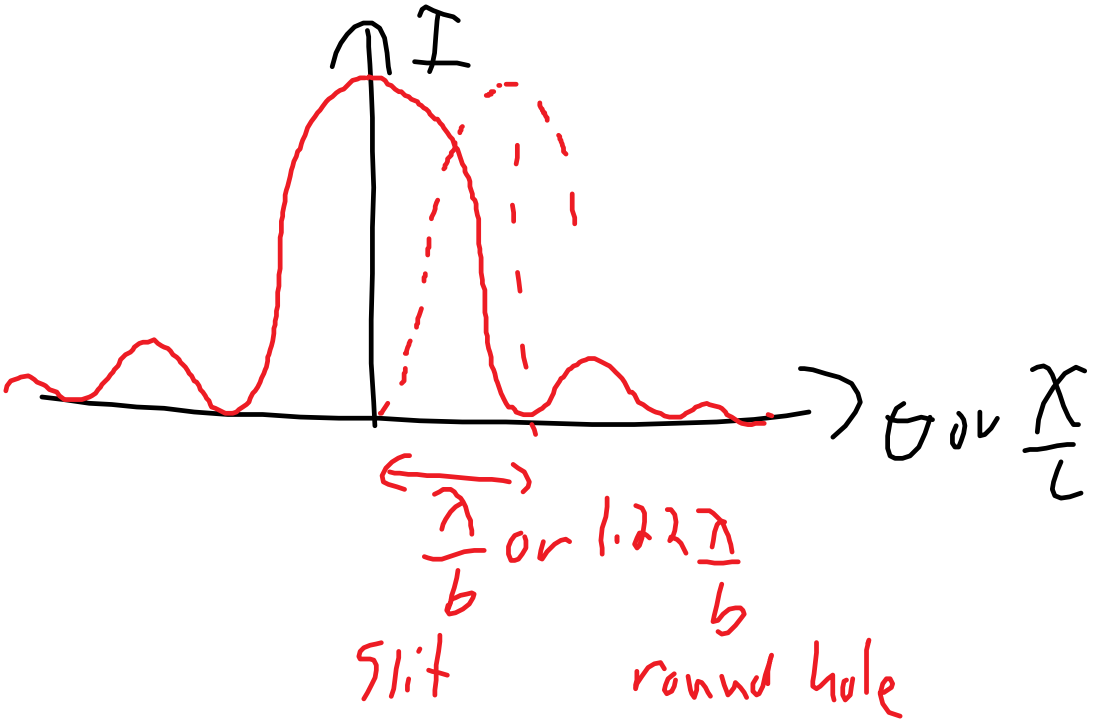
$$\boxed{\sin\theta = \frac{\lambda}{b} \approx \theta \approx \frac{x}{L}}$$

b is the width of the slit, in m
x is the distance from the middle of the central bright band to the first dark line. = half the width of the central bright band, in m.
L is the distance to the screen, in m.
θ=sinθ for small angles in radians between the centre of the bright band and the first dark line.

Circular aperture (round hole) the light diffracts and interferes as well but the equation is modified by a factor of 1.22

$\theta = 1.22\lambda/b \cong x/L$

graph intensity verses θ or x/L

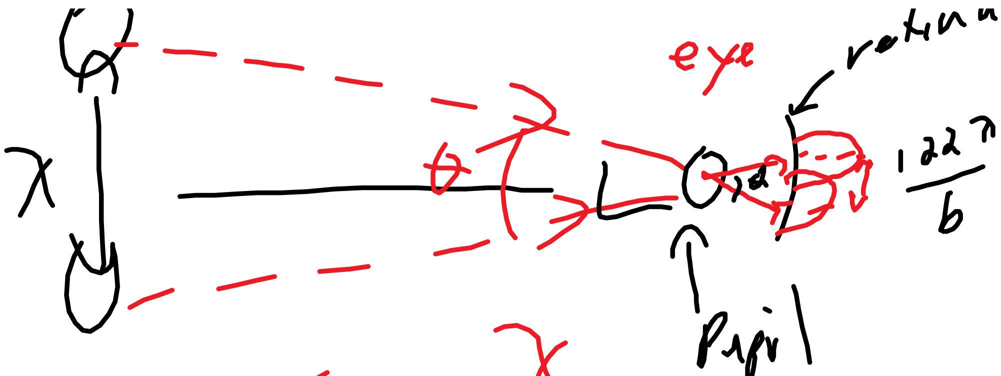


Your eye is circular aperture, diameter 5.0mm. A car's headlights are 1.70 m apart. To resolve the two headlights, the angle between the lights from your distance must be greater than $1.22\lambda/b$. At what distance will you begin to be able to resolve the two headlights using 522 nm light?

$x/L = 1.22\lambda/b$ $L = xb/1.22\lambda$ = (1.70m)(0.005)/($1.22 \times 5.22 \times 10^{-7}$)= 13 km

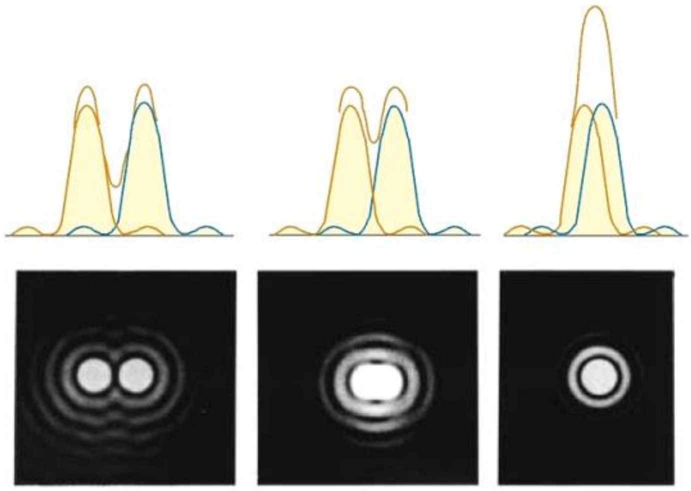
p946-950

Q35, 41, 45, 73, 81, 85, 89(hard), 96, 100



$\theta \sim \frac{x}{L}$

Rayleigh criterion for resolution



(a) (b) (c)